

What is claimed is:

1. An ink-jet recording head comprising:

a pressure producing device for changing a pressure in a pressure chamber containing an ink;

a plate-shaped member having a front surface and a back surface, the plate-shaped member having a partition wall formed on the front surface by a first etching process, the partition wall defining the pressure chamber, an ink supply passage and a common ink storage chamber, the plate-shaped member having a land formed on the back surface by a second etching process so as to correspond to the pressure chamber and be in contact with an extremity of the pressure generating device, the plate-shaped member having an elastic and deformable portion which is formed by the first etching process and the second etching process so as to surround the land, the elastic and deformable portion being capable of being elastically deformed by a deformation of the pressure generating device; and

a nozzle plate provided with a nozzle hole through which an ink droplet is ejected when the pressure in the pressure chamber is changed by the deformation of the pressure generating device, the nozzle plate being disposed on a side of the front surface of the plate-shaped member.

2. The ink-jet recording head according to claim 1, wherein the plate-shaped member includes a first layer having the front surface, a second layer having the back surface and an intermediate layer sandwiched between the first layer and the second layer, the first etching process etches a desired portion of the first layer selectively over the intermediate layer so that the first layer is penetrated, and the second etching process etches a desired portion of the second layer selectively over the intermediate layer so that the second layer is penetrated.

3. The ink-jet recording head according to claim 1, wherein the plate-shaped member includes a first layer having the front surface, a second layer having the back surface, an intermediate layer sandwiched between the first layer and the second layer, a first adhesive layer bonding the first layer and the intermediate layer together and a second adhesive layer

bonding the second layer and the intermediate layer together, the first etching process etches a desired portion of the first layer selectively over the first adhesive layer so that the first layer is penetrated, and the second etching process etches a desired portion of the second layer selectively over the second adhesive layer so that the second layer is penetrated.

4. The ink-jet recording head according to claim 2, wherein the first and the second layers are formed of a stainless steel, and the intermediate layer is formed of a polymer film.

5. The ink-jet recording head according to claim 1, wherein the plate-shaped member is formed of a single sheet which is made of a single material, the first etching process etches a desired portion of the front surface of the plate-shaped member in a depth equal to part of a thickness of the plate-shaped member, and the second etching process etches a desired portion of the back surface of the plate-shaped member in a depth equal to part of the thickness of the plate-shaped member.

6. The ink-jet recording head according to claim 5, wherein the plate-shaped member is made of a stainless steel.

7. An ink-jet recording head comprising:

a pressure generating device for changing a pressure in a pressure chamber containing an ink;

a plate-shaped member having a front surface, a back surface, the plate-shaped member having a partition wall formed on the front surface, the partition wall defining the pressure chamber, an ink supply passage and a common ink storage chamber, the plate-shaped member having a land formed on the back surface so as to correspond to the pressure chamber and be in contact with an extremity of the pressure generating device, the plate-shaped member having an elastic and deformable portion surrounding the land and being capable of being elastically deformed by a deformation of the pressure generating device, the plate-shaped member including a first layer having the front surface, a second layer having the back surface, and an intermediate layer sandwiched between the first and the second layers, and not having any adhesive layer or the like between the first and the intermediate layers nor between the second and

the intermediate layers; and

a nozzle plate provided with a nozzle hole through which an ink droplet is ejected when the pressure in the pressure chamber is changed by a deformation of the pressure generating device, the nozzle plate being disposed on a side of the front surface of the plate-shaped member.

8. The ink-jet recording head according to claim 7, wherein the partition wall is formed by etching a desired portion of the first layer selectively over the intermediate layer by a first etching process so that the first layer is penetrated, and

the land is formed by etching a desired portion of the second layer selectively over the intermediate layer by a second etching process so that the second layer is penetrated.

9. The ink-jet recording head according to claim 7, wherein the plate-shaped member is formed of a single sheet which is made of a single material,

the partition wall is formed by etching a desired portion of the plate-shaped member from the front surface by a first etching process in a depth equal to part of a thickness of the plate-shaped member, and

the land is formed by etching a desired portion of the plate-shaped member from the back surface by a second etching process in a depth equal to part of the thickness of the plate-shaped member.

10. The ink-jet recording head according to claim 9, wherein the plate-shaped member is made of a stainless steel.

11. The ink-jet recording head according to claim 1 further comprising a base member sandwiched between the plate-shaped member and the nozzle plate, the base member having an auxiliary ink storage chamber communicated with the ink storage chamber.

12. The ink-jet recording head according to claim 11, wherein the auxiliary ink storage chamber is offset from a position corresponding to the common ink storage chamber and partly overlaps the ink supply passage.

13. The ink-jet recording head according to claim 1

further comprising a base member sandwiched between the plate-shaped member and the nozzle plate, wherein the plate-shaped member and the nozzle plate are bonded to the base member with polyolefin adhesive films.

14. The ink-jet recording head according to claim 1, wherein an adhesive receiving groove is formed in the front surface of the plate-shaped member corresponding to the partition wall to suppress a protrusion of an adhesive when bonding the nozzle plate or the base member to the front surface of the plate-shaped member with the adhesive.

15. An ink-jet recording head manufacturing method of manufacturing an ink-jet recording head comprising a pressure generating device for changing a pressure in a pressure chamber containing an ink; a plate-shaped member having a front surface and a back surface, the plate-shaped member having a partition wall formed on the front surface defining the pressure chamber, an ink supply passage and a common ink storage chamber, the plate-shaped member having a land formed on the back surface so as to correspond to the pressure chamber and be in contact with an extremity of the pressure generating device, the plate-shaped member having an elastic and deformable portion surrounding the land and being capable of being elastically deformed by a deformation of the pressure generating device; and a nozzle plate provided with a nozzle hole through which an ink droplet is ejected when the pressure in the pressure chambers is changed by the deformation of the pressure producing device, the nozzle plate being disposed on a side of the front surface of the plate-shaped member; the ink-jet recording head manufacturing method comprising:

a first etching step for etching the plate-shaped member to form the partition wall on the front surface of the plate-shaped member;

a second etching step for etching the plate-shaped member to form the land on the back surface of the plate-shaped member; and

a nozzle plate attaching step for attaching the nozzle plate directly to or via another member to the front surface of

the plate-shaped member.

16. The ink-jet recording head manufacturing method according to claim 15, wherein the plate-shaped member includes a first layer having the front surface, a second layer having the back surface and an intermediate layer sandwiched between the first and the second layers, the first etching step etches a desired portion of the first layer selectively over the intermediate layer so that the first layer is penetrated, and the second etching step etches a desired portion of the second layer selectively over the intermediate layer so that the second layer is penetrated.

17. The ink-jet recording head manufacturing method according to claim 15, wherein the plate-shaped member includes a first layer having the front surface, a second layer having the back surface, an intermediate layer sandwiched between the first and the second layers, a first adhesive layer bonding the first layer and the intermediate layer together and a second adhesive layer bonding the second layer and the intermediate layer together, the first etching step etches a desired portion of the first layer selectively over the first adhesive layer so that the first layer is penetrated, and the second etching step etches a desired portion of the second layer selectively over the second adhesive layer so that the second layer is penetrated.

18. The ink-jet recording head manufacturing method according to claim 15, wherein the plate-shaped member is formed of a single sheet which is made of a single material, the first etching step etches a desired portion of the front surface of the plate-shaped member in a depth equal to part of a thickness of the plate-shaped member, and the second etching step etches a desired portion of the back surface of the plate-shaped member in a depth equal to part of the thickness of the plate-shaped member.

19. The ink-jet recording head manufacturing method according to claim 15, further comprising a step of disposing a base member having an auxiliary ink storage chamber communicated with the common ink storage chamber between the plate-shaped member and the nozzle plate.

20. The ink-jet recording head manufacturing method according to claim 19, wherein the auxiliary ink storage chamber is disposed so that the auxiliary ink storage chamber is offset from a position corresponding to the common ink storage chamber and partly overlaps the ink supply passage.

21. The ink-jet recording head manufacturing method according to claim 15, further comprising steps of disposing a base member between the plate-shaped member and the nozzle plate, and bonding the plate-shaped member and the nozzle plate to the base member with polyolefin adhesive films.

22. The ink-jet recording head manufacturing method according to claim 15, wherein an adhesive receiving groove is formed in the front surface of the plate-shaped member corresponding to the partition wall to suppress a protrusion of the adhesive when bonding the nozzle plate or the base member to the front surface of the plate-shaped member with the adhesive.

23. An ink-jet recording head comprising:

a passage unit formed by superposing a nozzle plate having a nozzle hole, a passage plate provided with a passage including a pressure chamber communicated with the nozzle hole, and a vibrating plate covering an open end of the pressure chamber; and

a pressure generating device for deforming the vibrating plate to change a pressure in the pressure chamber;

wherein the passage plate has a front surface and a back surface, a connecting hole is formed in the front surface of the passage plate by a first etching process so as to be communicated with the nozzle hole, and the passage is formed in the back surface of the passage plate by a second etching process.

24. The ink-jet recording head according to claim 23, wherein the passage plate has a laminated structure including a first base plate having the front surface and provided with the connecting hole formed by the first etching process, a second base plate having the back surface and provided with the passage formed by the second etching process, and an etch terminating layer sandwiched between the first and the second base plates;

the connecting hole is formed by etching a desired portion

of the first base plate by the first etching process which is terminated by the etch terminating layer; and

the passage is formed by etching a desired portion of the second base plate by the second etching process which is terminated by the etch terminating layer.

25. The ink-jet recording head according to claim 24, wherein the connecting hole formed in the first base plate serves also as the nozzle hole, and the first base plate serves also as the nozzle plate.

26. The ink-jet recording head according to claim 24, wherein the etch terminating layer is formed of an adhesive layer.

27. The ink-jet recording head according to claim 24, wherein the second base plate is made of a metal, and the etch terminating layer is made of a metal which is harder to be etched than the metal forming the second base plate.

28. The ink-jet recording head according to claim 27, wherein the metal forming the second base plate is a stainless steel or nickel, and the metal forming the etch terminating layer is titanium, silver or gold.

29. The ink-jet recording head according to claim 23, wherein the passage plate is formed of a single sheet which is made of a single material, the first etching process etches a desired portion of the front surface of the passage plate in a depth equal to part of a thickness of the passage plate, and the second etching process etches a desired portion of the back surface of the passage plate in a depth equal to part of the thickness of the passage plate.

30. The ink-jet recording head according to claim 29, wherein the passage plate is made of a stainless steel.

31. The ink-jet recording head according to claim 23, wherein the pressure generating device is a piezoelectric vibrator of a longitudinal vibration mode.

32. The ink-jet recording head according to claim 23, wherein the pressure generating device is a piezoelectric vibrator of a flexural vibration mode.

33. The ink-jet recording head according to claim 23, wherein the passage formed in the back surface of the passage

plate by the second etching process is a space forming the pressure chamber, an ink supply passage through which an ink is supplied into the pressure chamber, and an ink storage chamber for storing an ink to be supplied into the pressure chamber.

34. The ink-jet recording head according to claim 33, wherein an auxiliary ink storage chamber is formed in the front surface of the passage plate so as to be communicated with the ink storage chamber.

35. The ink-jet recording head according to claim 23 further comprising an additional passage plate having same construction as the passage plate and superposed on the passage plate.

36. The ink-jet recording head according to claim 23, wherein a metal layer is attached to the back surface of the passage plate, and the metal layer is provided with a passage similar to the passage.

37. The ink-jet recording head manufacturing method of manufacturing an ink-jet recording head comprising: a passage unit formed by superposing a nozzle plate having a nozzle hole, a passage plate provided with a passage including a pressure chamber communicated with the nozzle hole, and a vibrating plate covering an open end of the pressure chamber, and a pressure generating device for deforming the vibrating plate to change a pressure in the pressure chamber, the ink-jet recording head manufacturing method comprising:

a first etching step for etching a plate-shaped member having a front surface and a back surface to form a connecting hole in the front surface so as to be communicated with the nozzle hole;

a second etching step for etching the plate-shaped member to form the passage including the pressure chamber in the back surface of the plate-shaped member; and

an assembling step for assembling the passage unit by laminating the nozzle plate and the vibrating plate to the front and the back surfaces, respectively, of the passage plate which is the plate-shaped member processed by the first and the second etching processes.



38. The ink-jet recording head manufacturing method according to claim 37, wherein the plate-shaped member includes a first member having the front surface, a second member having the back surface and an etch terminating layer sandwiched between the first and the second members, the first and the second etching processes are terminated by the etch terminating layer.

39. The ink-jet recording head manufacturing method according to claim 37, wherein the passage plate is formed of a single sheet which is made of a single material, the first etching process etches a desired portion of the front surface of the passage plate in a depth equal to part of a thickness of the passage plate, and the second etching process etches a desired portion of the back surface of the passage plate in a depth equal to part of the thickness of the passage plate.

40. The ink-jet recording head manufacturing method according to claim 37, wherein the passage formed in the back surface of the passage plate by the second etching process is a space forming the pressure chamber, an ink supply passage through which an ink is supplied into the pressure chamber, and an ink storage chamber for storing an ink to be supplied into the pressure chamber.

41. The ink-jet recording head manufacturing method according to claim 40, wherein an auxiliary ink storage chamber is formed in the front surface of the plate-shaped member so as to be communicated with the ink storage chamber when forming the connecting hole by the first etching process.

42. An ink-jet recording head comprising:

a passage unit including a nozzle plate having a nozzle hole, a passage plate provided with a pressure chamber communicated with the nozzle hole and an ink storage chamber for storing an ink to be supplied into the pressure chamber, and a vibrating plate covering an open end of the pressure chamber; and

a piezoelectric vibrator of a longitudinal vibration mode for deforming the vibrating plate to change a pressure in the pressure chamber;

wherein the passage plate includes a first base plate

provided with the pressure chamber, a second base plate provided with a connecting hole connecting the pressure chamber to the nozzle hole and the ink storage chamber, and an ink supply passage plate provided with an ink supply passage connecting the pressure chamber to the ink storage chamber and sandwiched between the first and the second base plates, the ink storage chamber at least partly overlapping the pressure chamber; and

the first base plate includes a first etching plate provided with the pressure chamber, a first etch terminating layer serving as the vibrating plate, and a second etching plate forming a land to be in contact with the piezoelectric vibrator on a surface of the vibrating plate; the pressure chamber being formed by etching a desired portion of the first etching plate to the first etch terminating layer, and the land is formed by etching a desired portion of the second etching plate to the second etch terminating layer.

43. The ink-jet recording head according to claim 42, wherein a damping chamber capable of absorbing a pressure variation in the ink storage chamber is formed in the second base plate on a side of the nozzle plate.

44. The ink-jet recording head according to claim 43, wherein the second base plate includes a third etching plate provided with the ink storage chamber, a fourth etching plate provided with the damping chamber, and a second etch terminating layer sandwiched between the third and the fourth etching plates, the ink storage chamber is formed by etching a desired portion of the third etching plate to the second etch terminating layer, and the damping chamber is formed by etching a desired portion of the fourth etching plate to the second etch terminating layer.

45. The ink-jet recording head according to claim 42, wherein the etch terminating layer is an adhesive layer.

46. The ink-jet recording head according to claim 42, wherein the etching plate is made of a metal, and the etch terminating layer is made of a metal harder to be etched than the metal forming the etching plate.

47. The ink-jet recording head according to claim 46, wherein the metal forming the etching plate is a stainless steel

or nickel, and the metal forming the etch terminating layer is titanium, silver or gold.

48. The ink-jet recording head according to claim 42, wherein the etch terminating layer is a polymer film, and the etch terminating layer is laminated to the etching plate via an adhesive layer.

49. An ink-jet recording head comprising:

a passage unit including a nozzle plate having a nozzle hole, a passage plate provided with a pressure chamber communicated with the nozzle hole, an ink storage chamber for storing an ink to be supplied into the pressure chamber, and a vibrating plate covering an open end of the pressure chamber; and

a pressure producing device for deforming the vibrating plate to change a pressure in the pressure chamber;

wherein the passage plate includes a laminated structure formed by sandwiching an etch terminating layer between a pair of etching plates, at least either the pressure chamber or the ink storage chamber is formed by etching a desired portion of the etching plate to the etch terminating layer, and the etch terminating layer serves as at least either a flexible plate defining a part of the ink storage chamber or the vibrating plate.

50. An ink-jet recording head manufacturing method of manufacturing an ink-jet recording head comprising a passage unit including a nozzle plate having a nozzle hole, a passage plate provided with a pressure chamber communicated with the nozzle hole, an ink storage chamber for storing an ink to be supplied into the pressure chamber and a vibrating plate covering an open end of the pressure chamber, and a pressure producing device with a longitudinal vibrating mode for deforming the vibrating plate to change a pressure in the pressure chamber; the ink-jet recording head manufacturing method comprising the steps of:

forming a laminated structure by sandwiching a first etch terminating layer between a first etching plate and a second etching plate;

forming the pressure chamber by etching a desired portion of the first etching plate to the first etch terminating layer;

forming a land by etching a desired portion of the second etching plate to the first etch terminating layer; and

bonding a second base plate provided with a connecting hole for connecting the pressure chamber to the nozzle hole and the ink storage chamber to a first base plate having the laminated structure provided with the pressure chamber and the land so that the ink storage chamber at least partly overlap the pressure chamber.

51. The ink-jet recording head manufacturing method according to claim 50 further comprising the step of forming the second base plate which comprises the steps of:

forming a laminated structure by sandwiching a second etch terminating layer between a third etching plate and a fourth etching plate;

forming the ink storage chamber and the connecting hole by etching desired portions of the third etching plate to the second etch terminating layer; and

forming a damping chamber by etching a desired portion of the fourth etching plate to the second etch terminating layer, the damping chamber being capable of absorbing a pressure variation in the ink storage chamber.

52. The ink-jet recording head manufacturing method according to claim 50 further comprising the step of sandwiching an ink supply passage plate provided with an ink inlet passage connecting the ink storage chamber to the pressure chamber between the first and the second base plates.

53. The ink-jet recording head manufacturing method according to claim 50, wherein the nozzle plate, the second base plate, the ink supply passage plate and the first base plate are bonded together by adhesive films, portions of the adhesive films corresponding to openings formed in the nozzle plate, the second base plate, the ink supply passage plate and the first base plate, respectively, are removed before the adhesive films are attached to the nozzle plate, the second base plate, the ink supply passage plate and the first base plate.